SYMPOSIUM OP'24

18 Nov. 2024

Ocean Predict

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Shaping the future: The importance of structuring our international collaboration in ocean forecasting

Pierre BAHUREL with the help of Enrique ALVAREZ FANJUL
Mercator Ocean International

Ocean Predict

We are a vibrant, innovative and reliable ocean forecasting community, delivering scientific and operational solutions that work.

We're moving fast in the international structuring of our community.

By aligning Science/Services/Governance innovations, we're shaping an authoritative future to our Ocean Prediction community.

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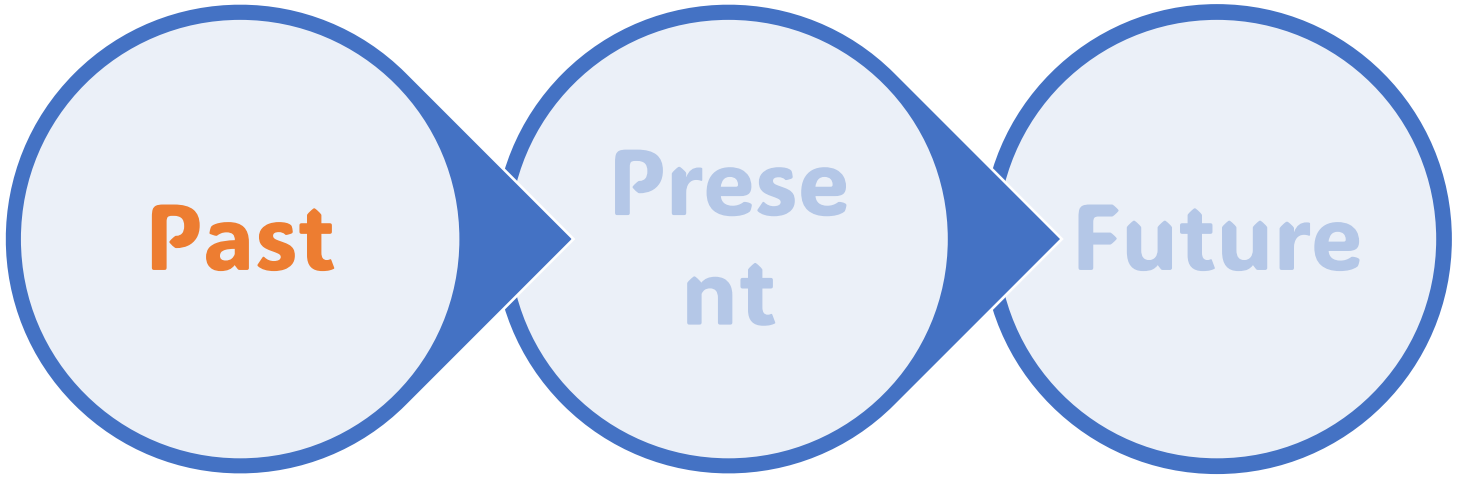
1.- What have we done since last time ?



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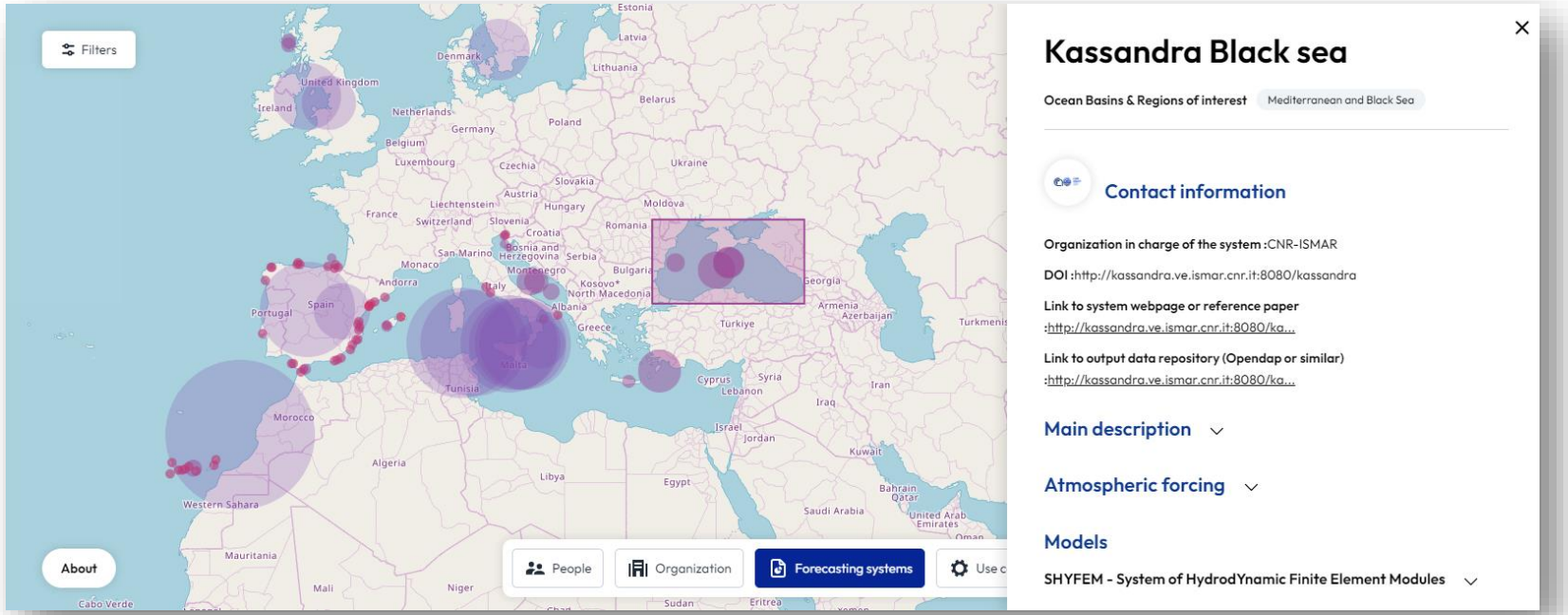
Where are we now?

A snapshot of the actual situation:

- A wide variety of ocean prediction centres and services
- Powerful services linked to users
- A constantly growing number of users
- Strong geographical imbalances
- No sufficient integration
- Systems complex to develop and operate

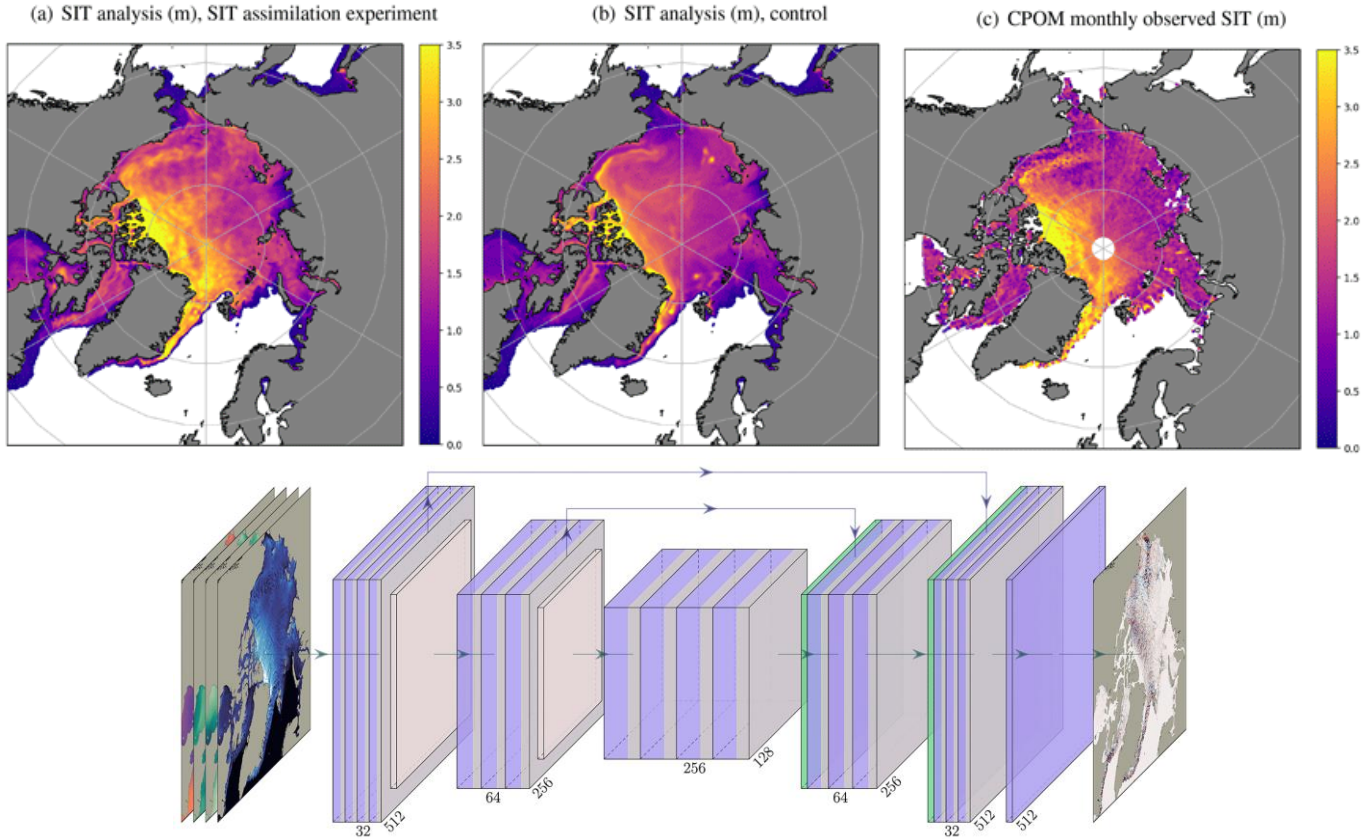
Source: https://www.unoceanprediction.org/en/atlas/models



Let's explore some recent developments around the globe!

Examples of recent developments:
Arctic

- Assimilation of sea ice thickness from altimetry is spreading:
  - Should improve heat, freshwater, light & momentum fluxes between ocean and atmosphere
- Studying potential for surrogate models (AI) for extra-large ensemble simulations or to replace parts of models (dynamics, melt ponds…)



Surrogate sea ice model using convolutional U-Net architecture

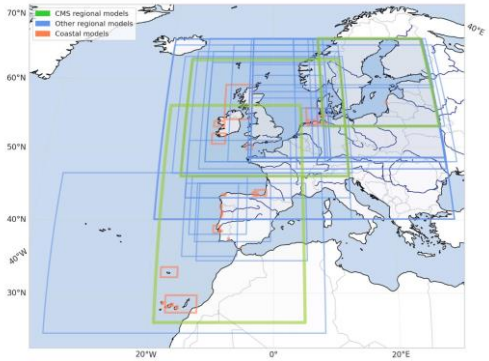
Ocean Prediction | ARCTIC

Source: Heather Regan, OceanPrediction DCC Arctic Regional Team

Examples of recent developments:
North-East Atlantic

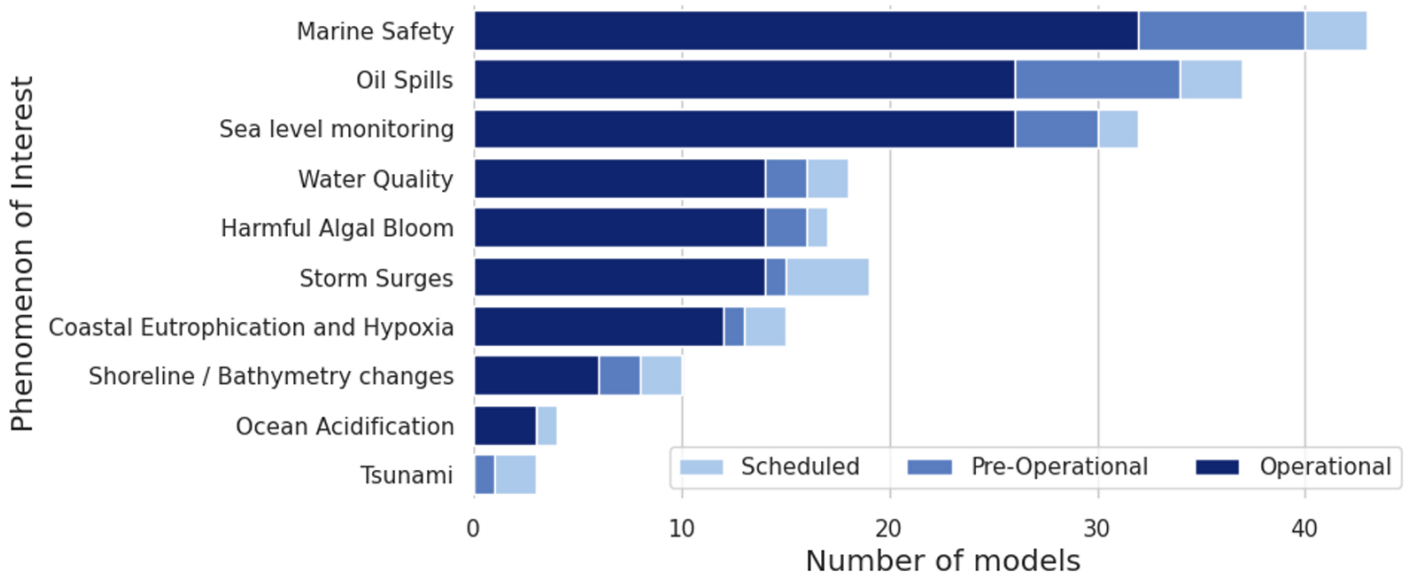
Recent Highlights:

- Integration of ensemble-based systems and data assimilation for marine safety, oil spill, and sea level monitoring
- AI and machine learning advancements



Copernicus Marine Service

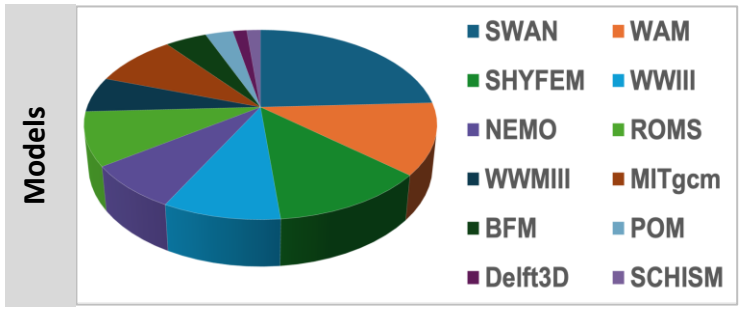
A mature panorama of forecasting systems and applications mostly nested on Copernicus products

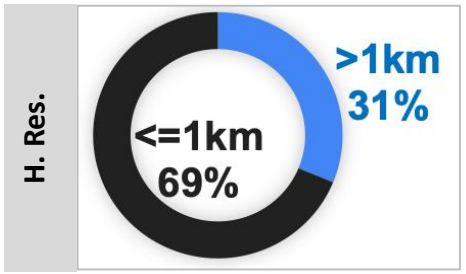


Ocean Prediction | NORTH-EAST ATLANTIC

Source: Ghada el Serafy, Loreta Cornacchia, OceanPrediction DCC NE AtlanticTeam

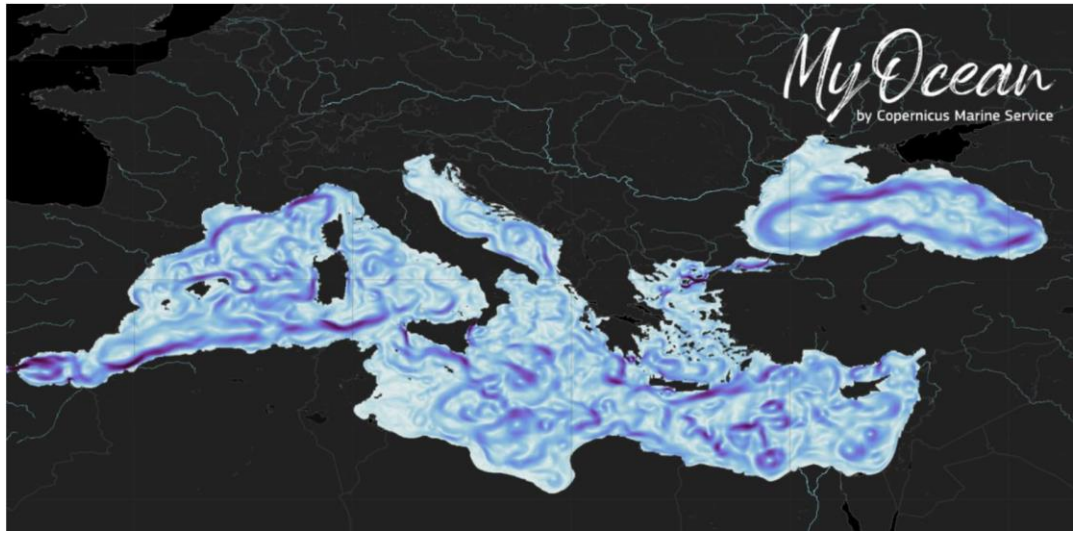
Examples of recent developments:
Mediterranean and Black Sea





Copernicus Marine Service

A mature panorama of **forecasting systems and applications** mostly nested on Copernicus products



Copernicus Marine Mediterranean

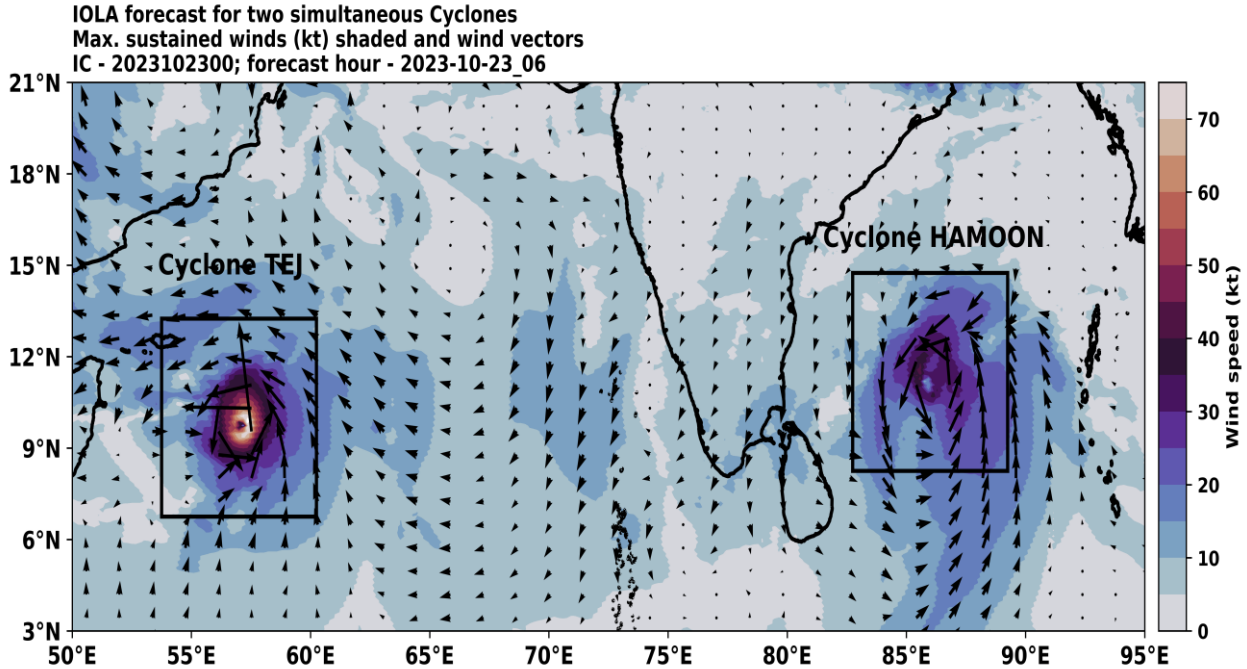
Ocean Prediction | MEDITERRANEAN AND BLACK SEA

Source: Emanuela Clementi, OceanPrediction DCC Mediterranean and Black Sea Regional Team

Examples of recent developments:
Indian Seas

Next-generation Indian Ocean-land-Atmosphere (IOLA)

- Coupled regional modeling system for severe weather and ocean state
- It Simulates and forecasts severe weather events ranging from convective scale events to Tropical Cyclones.
- It has 1.5 km high resolution relocatable two-way interactive multiple nests over inland, coastal zone, and open ocean.



Ocean Prediction | INDIAN SEAS

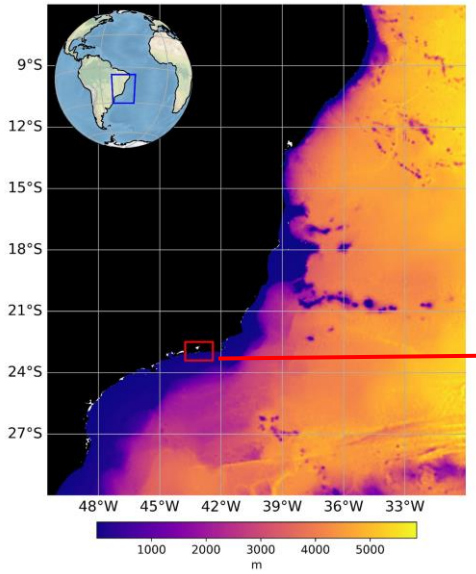
Source: Sudheer Joseph, OceanPrediction DCC Mediterranean and Black Sea Regional Team

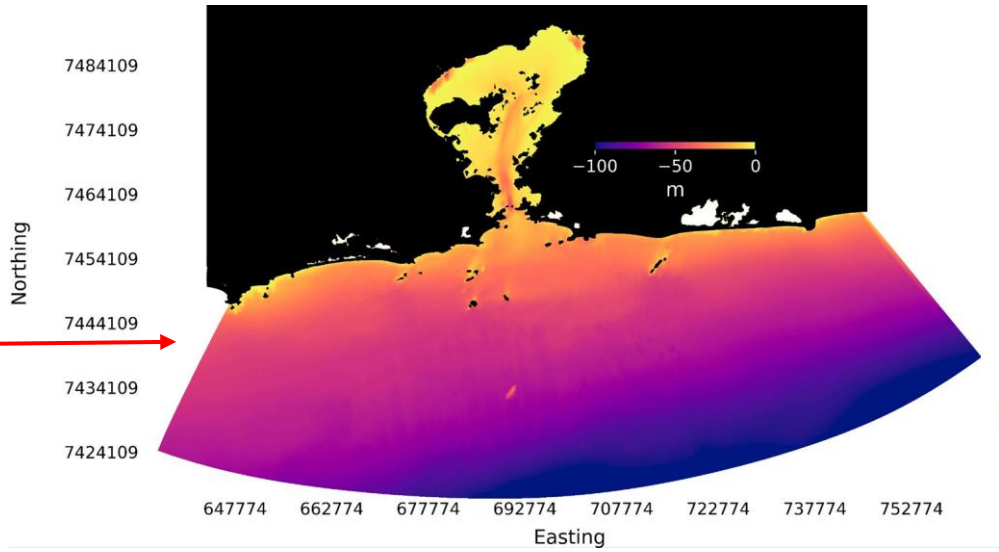
Examples of recent developments:
South and Central America

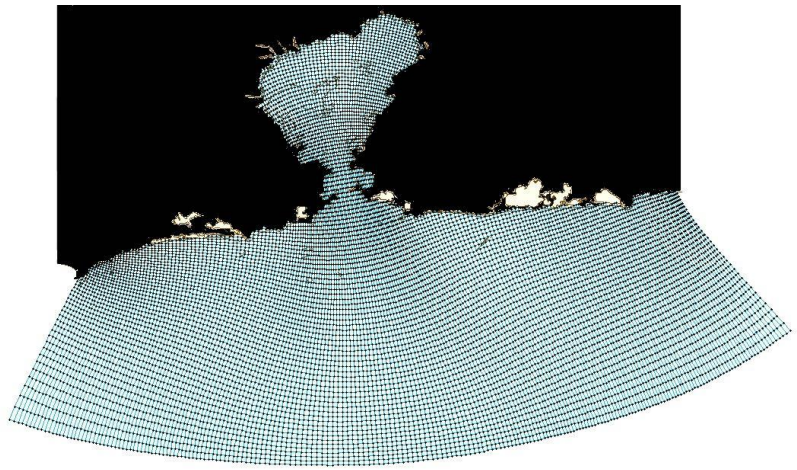
SiMCosta – Sistema de Monitoramento da Costa Brasileira | Rede Nacional de Observação e Monitoramento Oceânico ReNOMO | MOVAR | Grupo | Deltares | COPPE

Forecast System for the Guanabara Bay - Rio de Janeiro - Brazil

2D Delft3D FM hydrodynamic model nested in 1/36° (HYCOM): Soon 3D







Ocean Prediction | SOUTH AND CENTRAL AMERICA

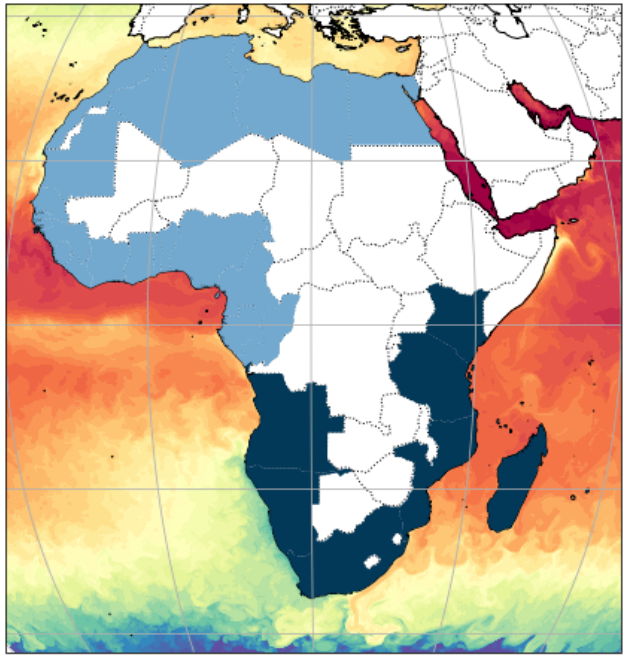
Source: Mauro Cirano, OceanPrediction DCC South and Central America Regional Team

Examples of recent developments:
Africa

Setting the scene for African Forecast Systems

NATIONAL OCIMS

Locally developed, cost-effective, regionally optimized forecast systems and downstream services



MarCNoWA

GMES AND AFRICA

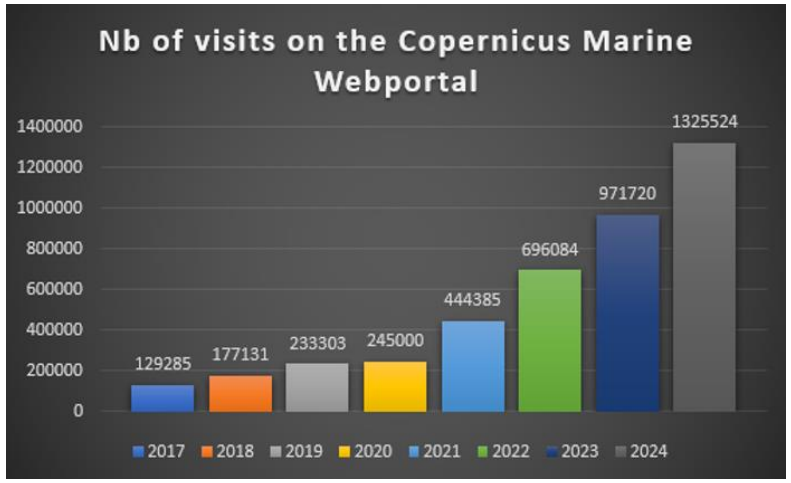
African Union

MarCOSIO
MARINE AND COASTAL OPERATIONS FOR SOUTHERN AFRICA AND THE INDIAN OCEAN

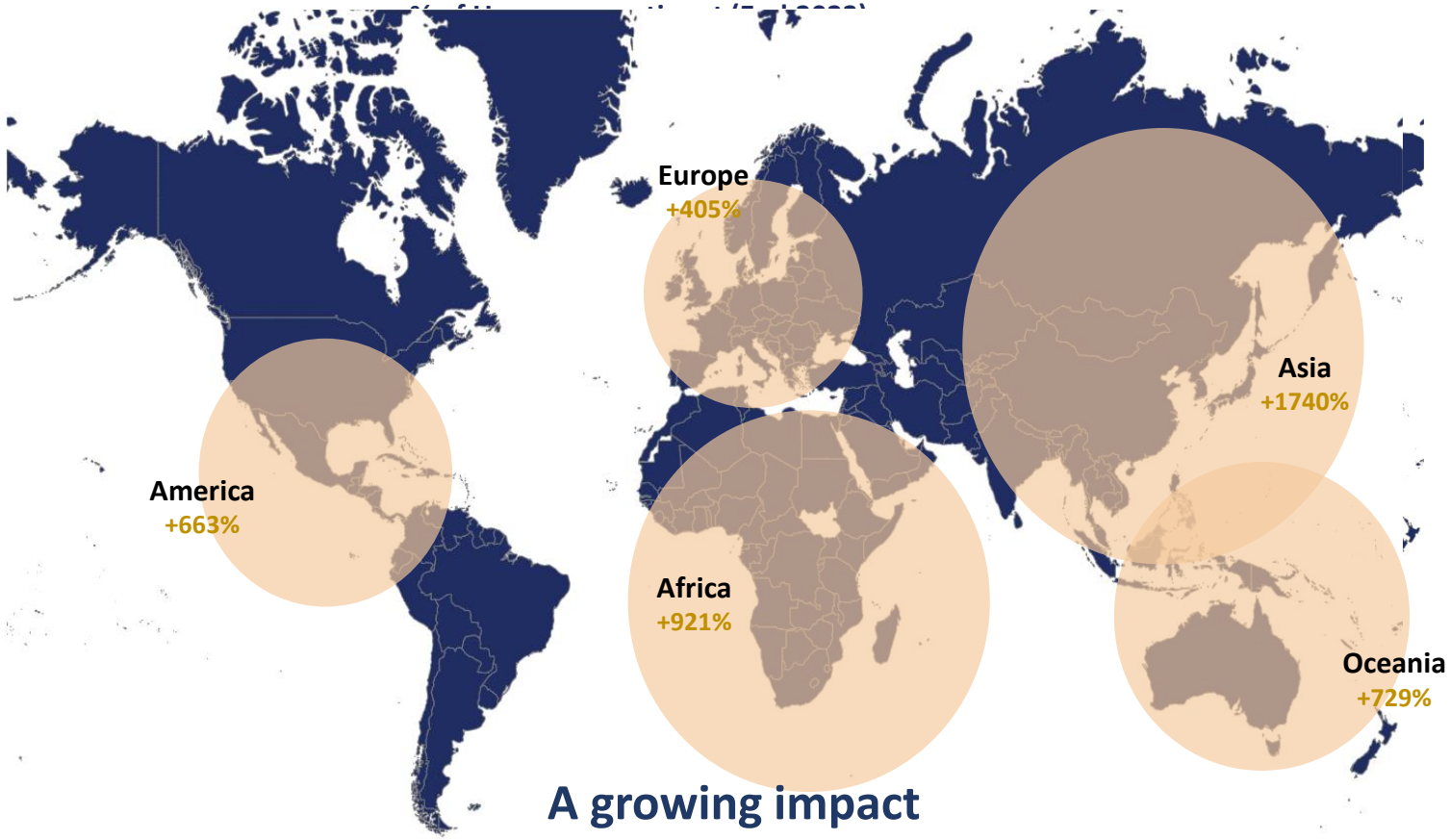
Ocean Prediction | AFRICAN SEAS

Source: Jennifer Veitch, OceanPrediction DCC African seas Sea Regional Team

Copernicus Marine users evolution

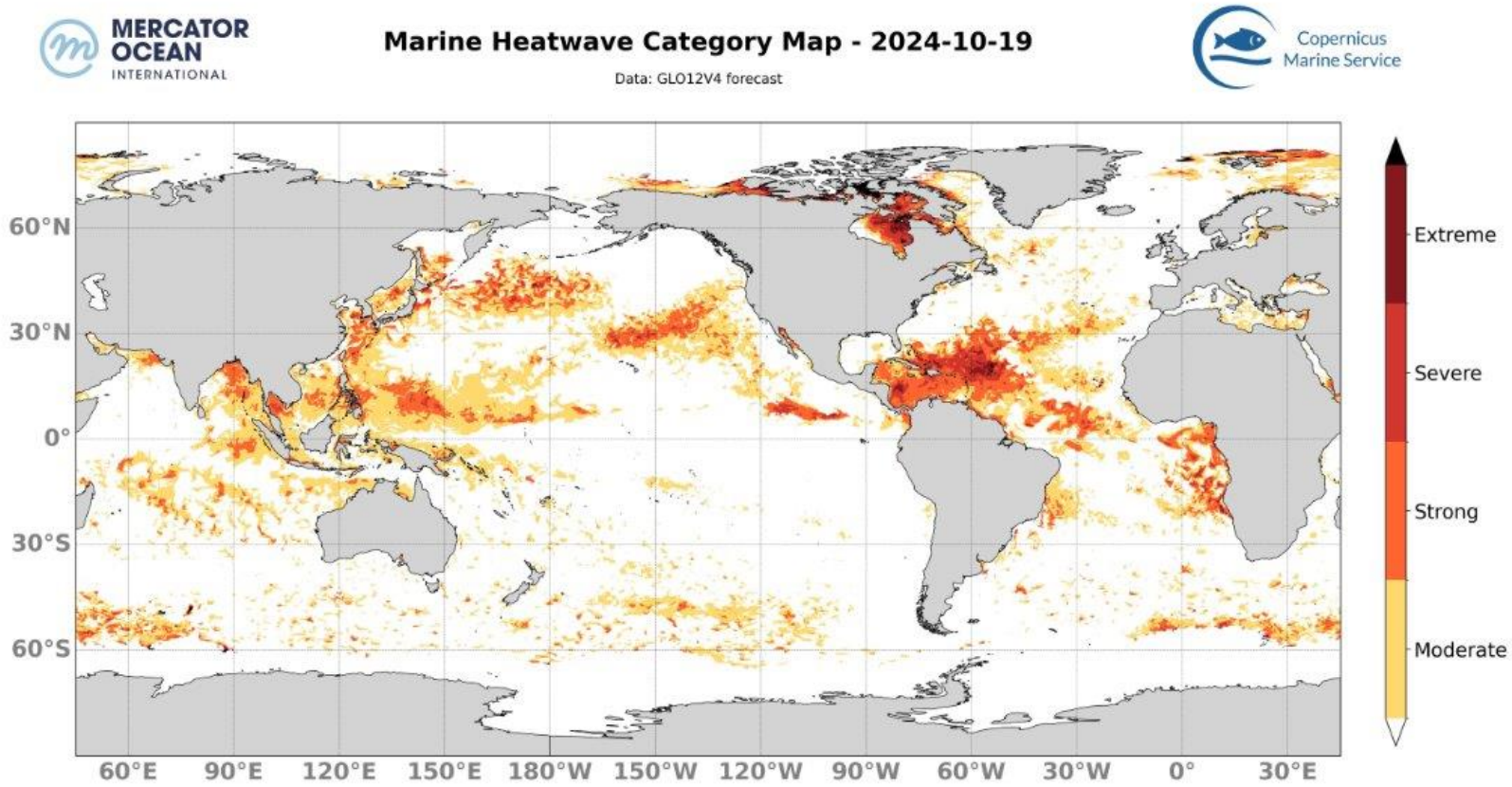


Evolution of Subscribers by continent (2016 - End 2023)



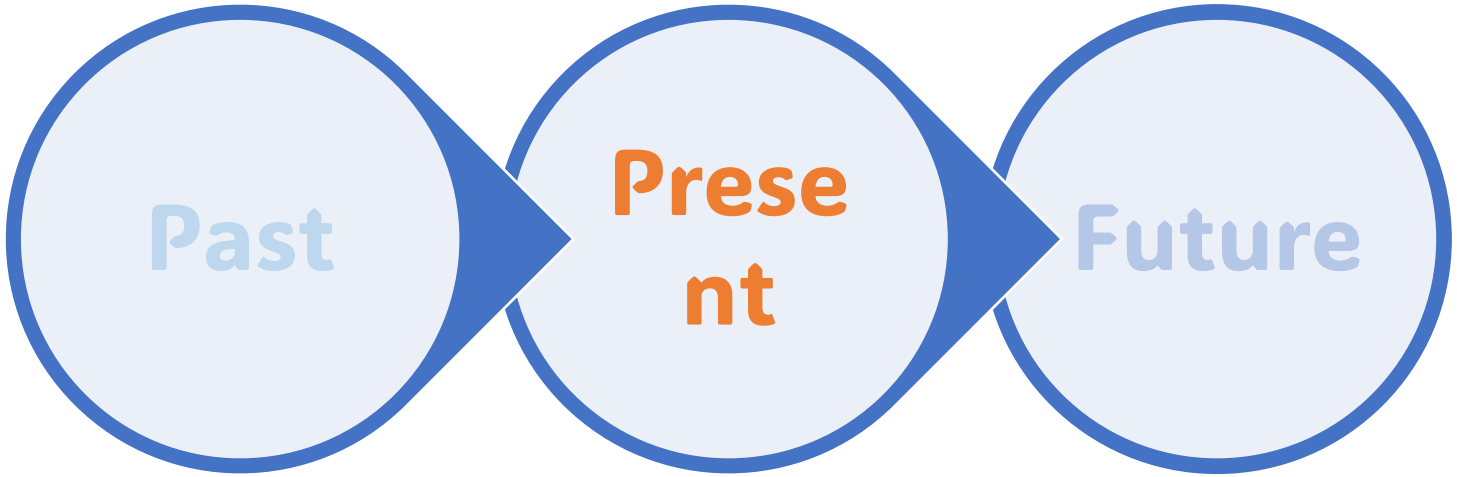
A growing impact

Real time monitoring of SST and Marine Heatwaves



Weekly Bulletin and Monthly synthesis

2 – What are we preparing today ?



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We're moving fast in the international structuring of our community

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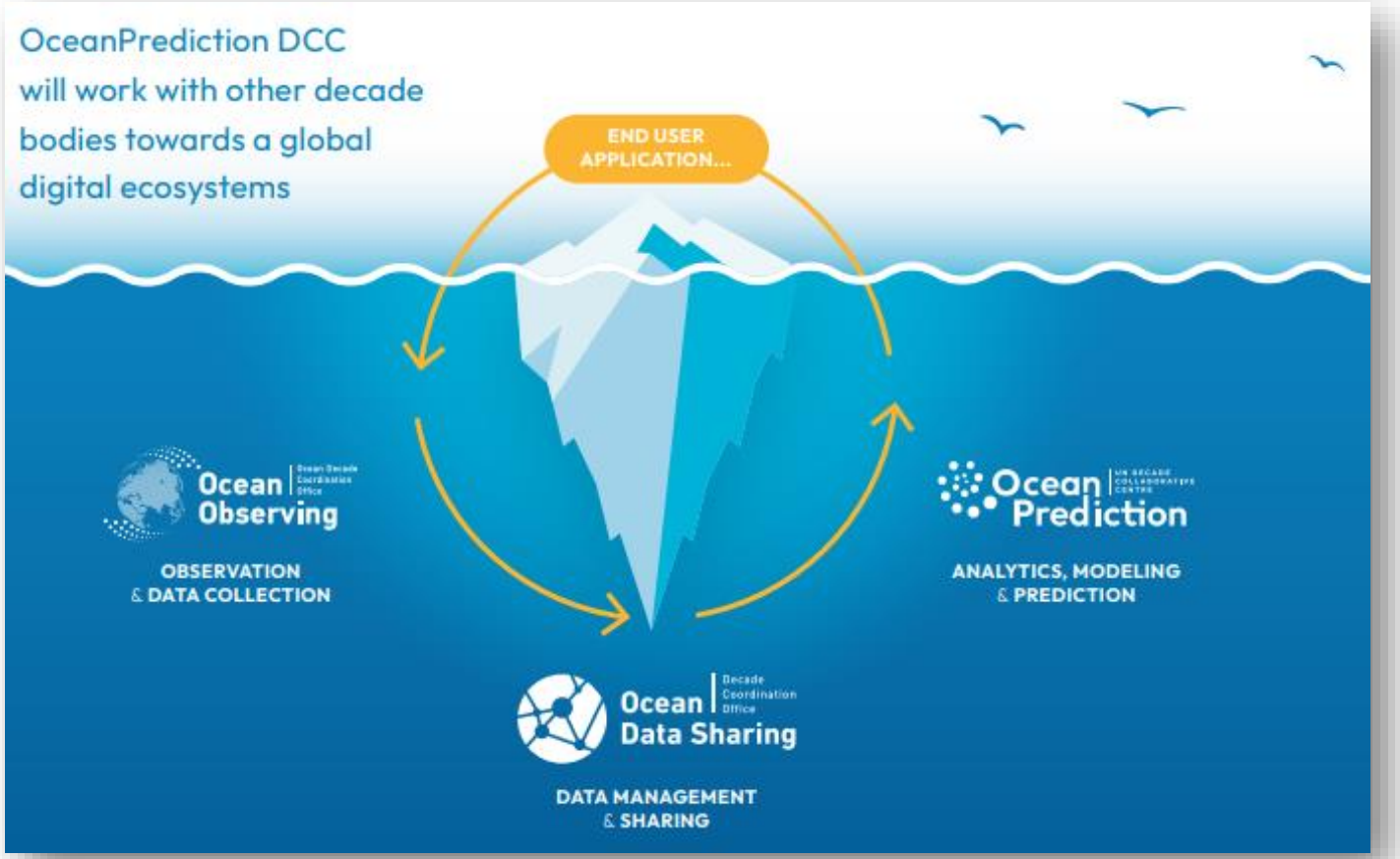
The UN Decade says 1 = 3

One Ocean = Obs+Data+Prediction



ForeSea

DITTO
Digital Twins of the Ocean

Ocean best practices

CoastPredict
with The Global Ocean Observing System

UN environment programme GEMS OCEAN

⋮

One ocean, one digital ecosystem

OceanPrediction Decade Collaborative Centre

2020: THE OCEAN FORECAST
WE HAVE

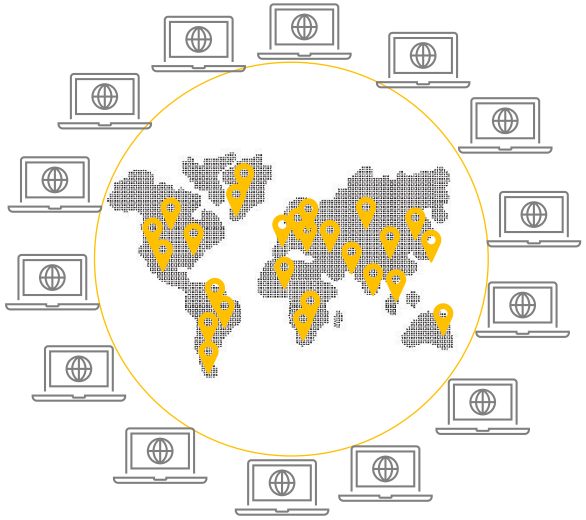
- Useful but partially disconnected services
- Strong geographical imbalances

OceanPrediction DCC VESSEL

Captain: UN Ocean Decade
Chief engineer: Decade actions and DTO
Crew: OceanPrediction DCC community
Navigator: OceanPrediction DCC

Ocean Prediction | UN DECADE COLLABORATIVE CENTER

2030: THE OCEAN FORECAST
WE WANT

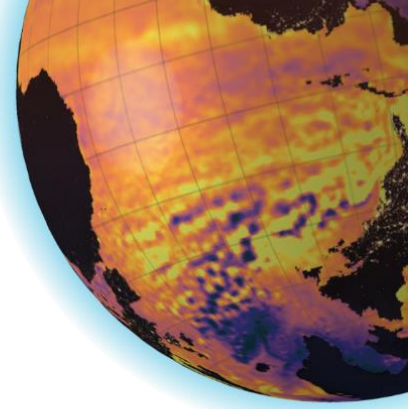


- Connected community and services
- Many robust systems worldwide

the UN Decade **OceanPrediction Collaborative Centre**

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

OceanPredict's legacy for the UN decade



Ocean Prediction Capacity of the Future

ForeSea

- Advancing the science, capacity, efficacy, use, and impact of ocean prediction systems.
- Impactful, relevant, integrated and interconnected ocean prediction systems
- Contributing to a seamless end to end ocean information value chain

Ocean Predict

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DITTO

Digital Twins of the Ocean

VISION

Digital Twin Ocean to support **ocean protection ocean governance a sustainable Blue Economy**

MISSION

Develop and share a **common understanding** of DTO, **Best practice,** Advanced **digital framework** for DTO

AMBITION

DTO will enable to address **WHAT IF** questions based on **shared data, model, knowledge**

Thematic Working Groups and Use Cases are the two pillars for DITTO's activities

DITTO promotes co-design of twins, education and uptake to demonstrate the value in digital twins

https://ditto-oceandecade.org

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Ocean Predict

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DITTO

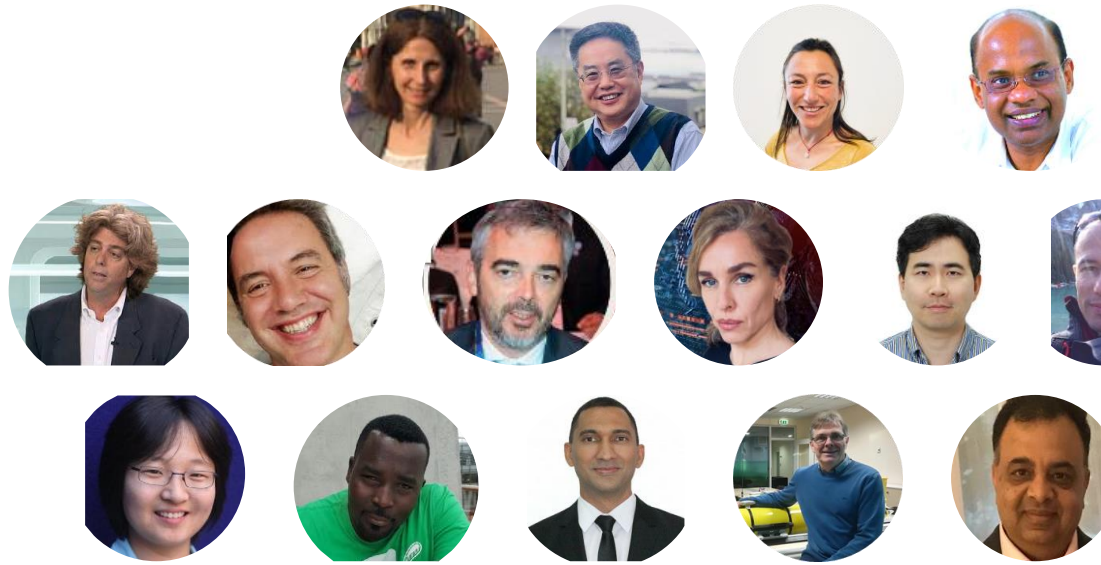
Digital Twins of the Ocean

GOVERNANCE 2024-2027

Co-chairs: Joanna Staneva, Fei Chai, MarinaTonani, Swadhin Behera

Steering Committee:

17 members from 14 countries



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GOOS | CoastPredict
with The Global Ocean Observing System

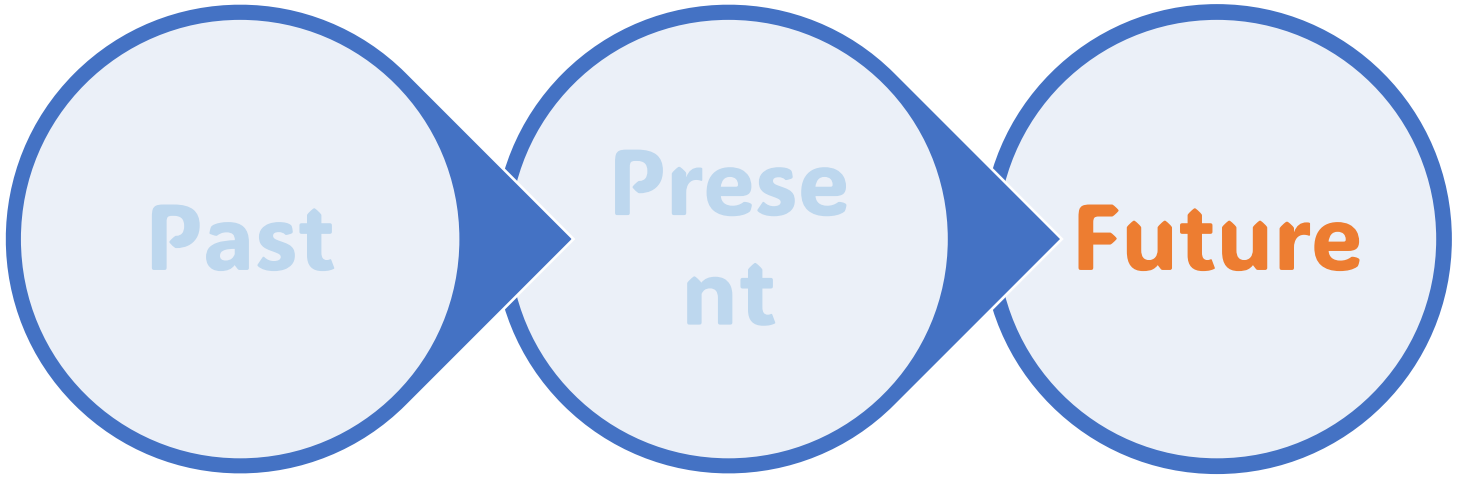
The last mile: CoastPredict

- Co-design and implement an **integrated coastal ocean observing and predicting system** adhering to best practices and standards, **designed as a global framework and implemented locally**

Responsive & fit-for-purpose multi-disciplinary systems into coast to address many challenges: storm surge, climate impacts, coastal erosion, shipping/ports, hypoxia, marine heatwaves, carbon sequestration, etc.

3 – How we are shaping an authoritative Ocean Prediction by innovating together in Science, Services, and Governance

Ocean Predict



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3 – How we are shaping an authoritative Ocean Prediction by innovating together in Science, Services, and Governance

Ocean Predict

unesco

Intergovernmental Oceanographic Commission

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Artificial Intelligence ?

XiHe: A Data-Driven Model for Global Ocean Eddy-Resolving Forecasting

Xiang Wang, Renzhi Wang, Ningzi Hu, Pinqiang Wang, Peng Huo, Guihua Wang, Huizan Wang, Senzhang Wang, Junxing Zhu, Jianbo Xu, Jun Yin, Senliang Bao, Ciqiang Luo, Ziqing Zu, Yi Han, Weimin Zhang, Kaijun Ren, Kefeng Deng, Junqiang Song

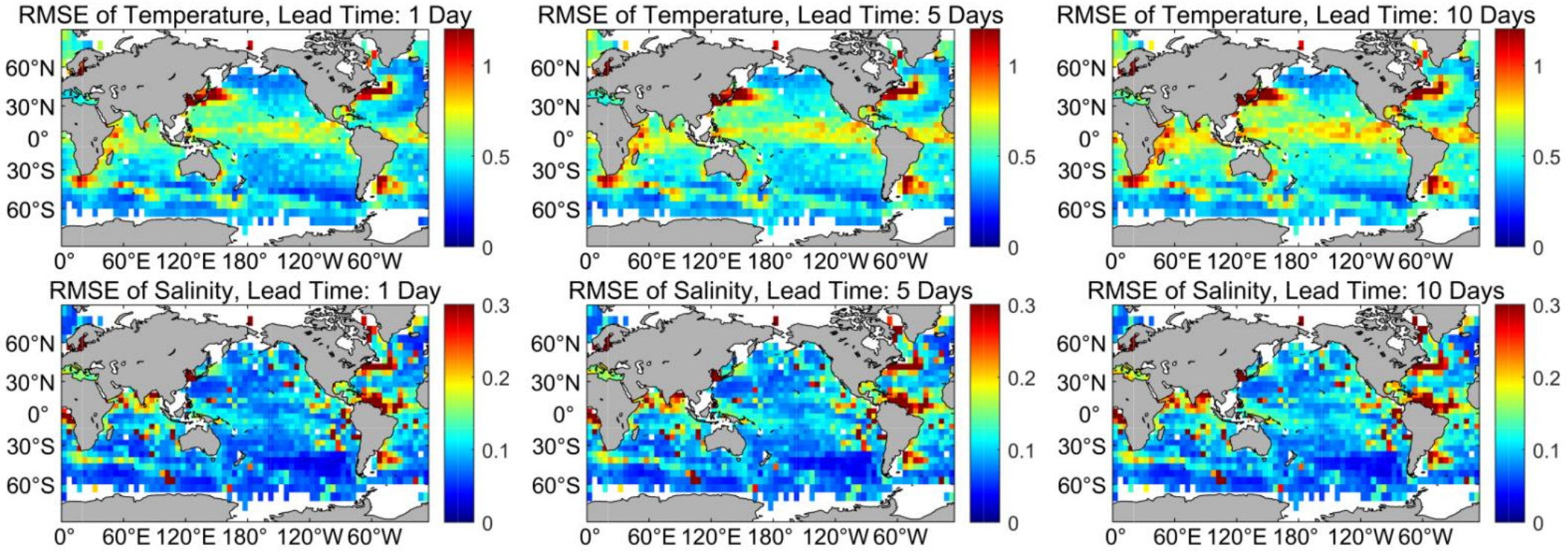
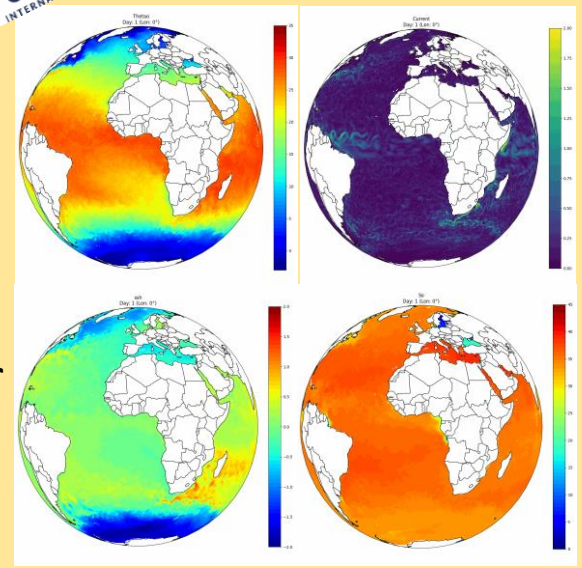


Fig. 5: The average RMSEs over vertical depth of the temperature and salinity between observation data and *XiHe* with lead times of 1-day, 5-day, and 10-day calculated on every $5° \times 5°$ area from Jan. 1st, 2019 to Dec. 31st, 2020. The observation comes from the IV-TT Class 4 framework.

Artificial Intelligence: new developments and data challenges

Ocean Forecast

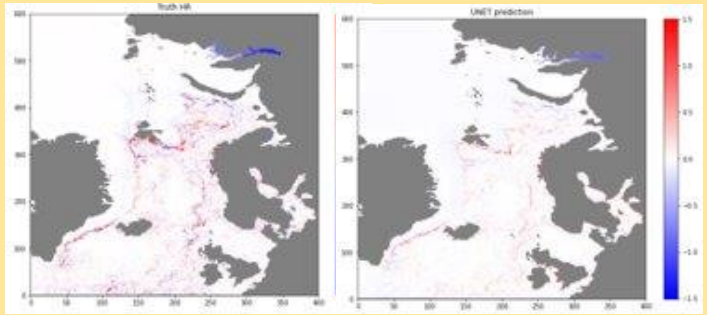
10 days forecast



Temperature, currents, Sea Level, Salinity Global ocean forecast
Trained with reanalysis
Intercomparison/data challenges with different groups, data set, methods

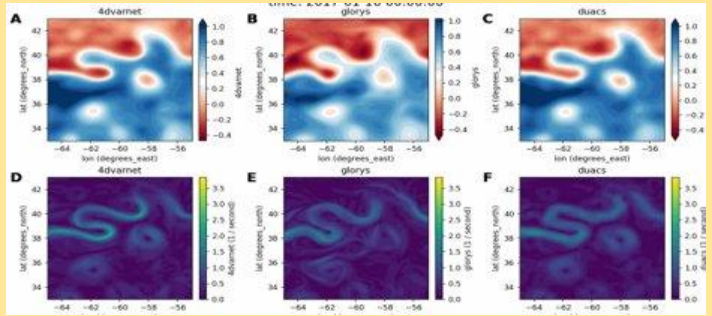
Data Assimilation

High resolution truth (left) and Neural Network Forecast (left)



Super Resolution
Data base including highr resolution (6km) and low resolution (12km) simulations to train Unet super resolution model
EnKF data assimilation for the low-resolution model

Reconstruction



Sea level reconstruction with 4Dvarnet
Trained with observations and simulations
Applied to other variables (turbidity)

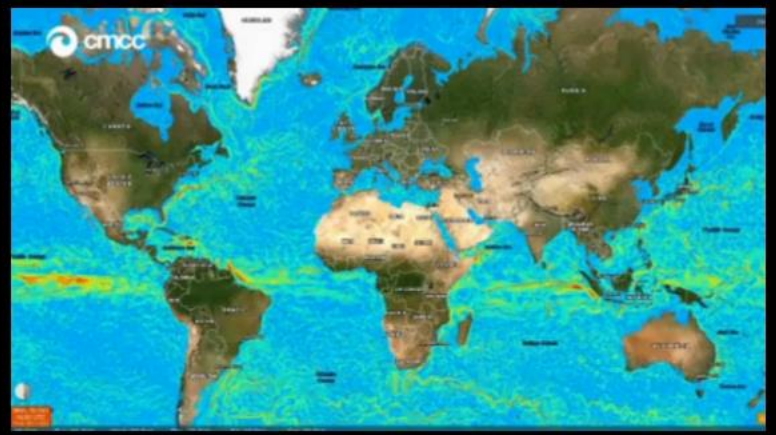
EU MISSIONS
RESTORE OUR OCEAN & WATERS

EDITO European Digital Twin Ocean
in cooperation with

Preparing New Systems & Services

The EU DTO powered by a global operational network...

Atlantic example, ©Deltares, The Netherlands



Mediterranean example, ©CMCC, Italy

Upgrading our governance

Mercator Ocean is transforming into *an intergovernmental organization* *for the development and exploitation of digital Ocean systems and information services*.

- The new organization is being founded by European States, is expected to be approved in June 2025 to enter into force in 2027.
- Non-European States will be invited to partner with the new organization, either as Associate Members, Collaborating Partners, or as full Member States.

MERCATOR OCEAN INTERNATIONAL

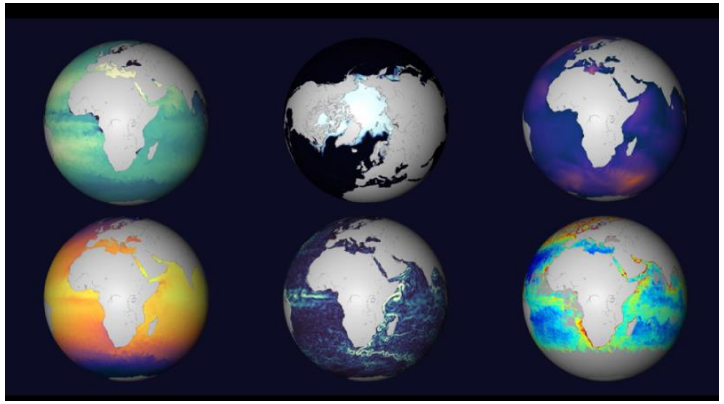
Upgrading our governance

Mercator Ocean is transforming into *an intergovernmental organization* *for the development and exploitation of digital Ocean systems and information services*.

The purpose of Mercator IGO is

- *to design, develop and operate world-class **digital Ocean systems** encompassing marine physics, biogeochemistry and ecosystems*
- *and to provide authoritative digital Ocean **information services** of general interest*
- *to Member **States** and **international** Ocean governance,*
- *including **operational Ocean forecast services**.*

MERCATOR OCEAN INTERNATIONAL



Conclusion

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Yes we are

2019 – 2025

2012 – 2018

2005 – 2011

1998 – 2004


2019, we socialize


2012, we want


2005, we feel


1998, we are

5

2025 – 2032

“WE SAY”


we say
that we are ready to deliver as one ocean prediction community,
with authoritative digital ocean systems and services
supporting effective ocean governance

Next year, in June 2025,
at the 3rd UN Ocean Conference,

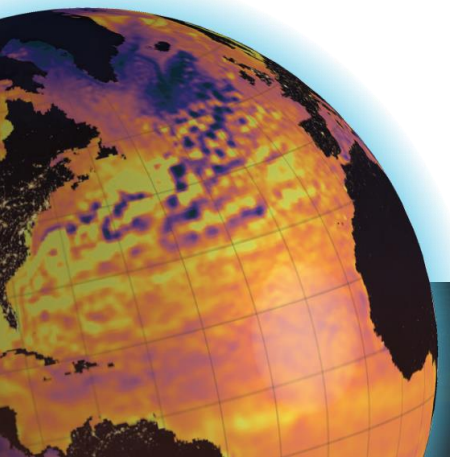
let's raise the **authoritative voice** of our OceanPrediction community,

and

call to action for supporting digital ocean systems and services for an effective science-based ocean governance.

UNITED NATIONS
OCEAN CONFERENCE
France, June 2025

DIGITAL OCEAN PAVILLON, in preparation



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ADVANCING OCEAN PREDICTION
SCIENCE FOR SOCIETAL BENEFITS
Thank you!
European Commission
Copernicus Marine Service
EU4oceanobs
INTERNATIONAL OCEAN GOVERNANCE
EU COMPONENT TO GLOBAL OCEAN OBSERVATIONS
esa
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES
Met Office
NERSC
MERCATOR OCEAN INTERNATIONAL
Australian Government
Bureau of Meteorology
Canada